Space Weather Technical Forecast

Issued on Friday 10 January 2025 at 13:06 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low solar activity during the last 24 hours with only C-class flares, the peak a C6.1 flare at 10/0942 UTC from near AR3945. There are eleven sunspot regions visible on the Earth-facing disc. AR3947 remains the largest and most magnetically complex sunspot region, with a weak delta spot configuration forming. Recently numbered AR3956 in the northeast has shown some rapid growth with penumbra forming on both leading and trailing spots. The remaining regions on the disc remain small and simple at present.

Due to a lack of recent SOHO coronagraph imagery combined with large gaps in STEREO coronagraph imagery the detection of CMEs is more uncertain than usual. A possible filament eruption near the centre disc on 09 Jan may bring some enhancement at Earth, however this can not be correlated with coronagraph imagery at present.

Solar Wind / Geomagnetic Activity: Solar winds were initially at background levels, becoming slightly elevated from around 10/0100 UTC, now around 420-470km/s. Density was average or below. The Interplanetary Magnetic Field, Bt, was weak to moderate, ranging between 5-10nT. The north-south component, Bz, was variable and generally weak, but with a brief moderate negative interval around 09/1432 UTC. Overall it ranged between +8 and -10nT. Phi angle was mainly positive (away from the Sun), with a brief negative interval (towards the Sun) between 10/0930-1030 UTC. Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES-18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was initially high, peaking at 1240 pfu at 09/1335 UTC, but has declined to background levels. The associated 24 hour fluence remained below the Active threshold on a slight declining trend, reading 4.11e7 integrated pfu at 10/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate with an ongoing chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: A lack of SOHO coronagraph imagery and STEREO imagery means that CME analysis is difficult and comes with increased uncertainty. A possible filament eruption from near AR3947 on 09 Jan may bring some enhanced geomagnetic activity over the

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UTC weekend. Solar winds are currently slightly elevated, perhaps due to the onset of the high speed stream from CH07/+ which is expected through Days 1-2 (10-11 Jan).

Geomagnetic activity is expected to be mostly Quiet to Unsettled, perhaps with the odd Active interval Days 1-2 (10-11 Jan) with any high speed stream influence. Any CME influence is likely to be rather dense, with a chance of G1 to G2 Minor/Moderate storms intervals on Days 2-3 (11-12 Jan), but this is very low confidence.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to remain near background levels, with only a slight chance of rising in response to any notable flares. GOES16 high energy electron flux is forecast to continue at Background to Moderate levels at first, perhaps rising to High through the forecast period. Electron fluence is not expected to reach Active thresholds at first, although a rising trend is possible later in the period.

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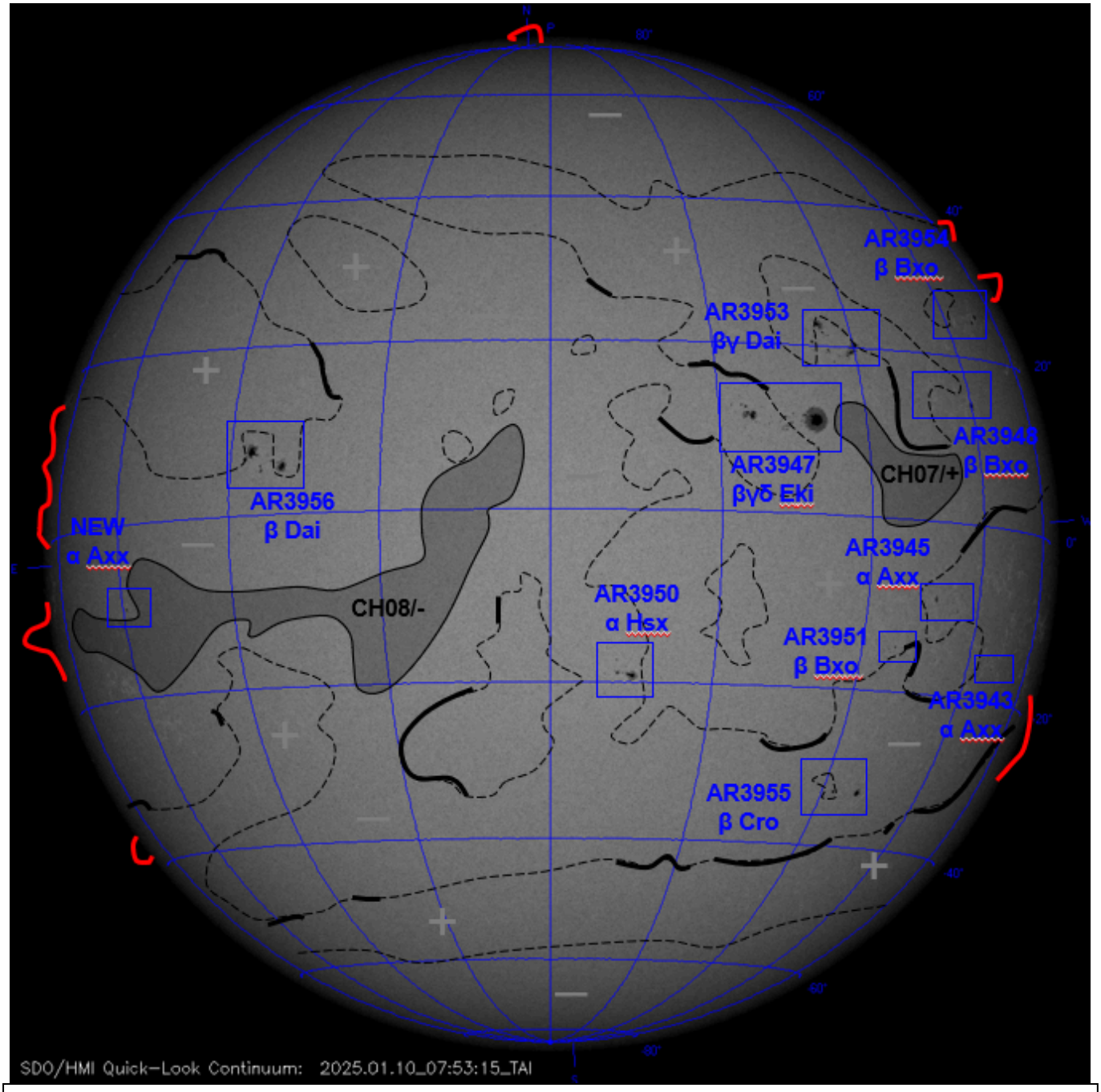
Figure 1: Solar Synoptic Map valid 10/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Solar winds have risen from background to slightly elevated levels, possibly due to a connection to CH07/+ in the western hemisphere. This is a little earlier than originally expected, and whilst this feature appears small, it is partially obscured by flux lines in imagery. On the previous rotation wind speeds up to 450 km/s were observed, with similar speeds expected this time round, perhaps persisting into Day 2 (11 Jan). CH08/-, currently in the eastern hemisphere, may begin to become geoeffective by the end of Day 4 (13 Jan), but more likely beyond this forecast period.

A filament eruption to the northeast of AR3947 appears on SDO/AIA 304 imagery and GONG H-alpha around 09/1030 UTC with an associated long duration C-class flare. Given the continued lack of SOHO coronagraph imagery combined with large gaps in STEREO imagery its difficult to ascertain if any material was directed towards Earth as a result of this eruption. Given its location near centre disc, it is possible that we could see an Earth-directed component, but this is treated with significant uncertainly. Estimating a CME speed of between 500-1000km/s would bring impacts at Earth somewhere between late (UTC) on Day 2 (11 Jan) to the early hours Day 4 (13 Jan).

Geomagnetic activity is expected to be mostly Quiet to Unsettled, perhaps with the odd Active interval Day 1 or 2 (10-11 Jan) with any high speed stream influence. Any CME influence is likely to be rather dense, with a chance of G1 to G2 Minor/Moderate storms and a very slight chance of G3/Strong storms intervals possible through Days 2-4 (11-14 Jan), however this is very low confidence due to the rough estimates used in its analysis.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	5	20	25	15
Strong	**G3**	No	1	5	10	5
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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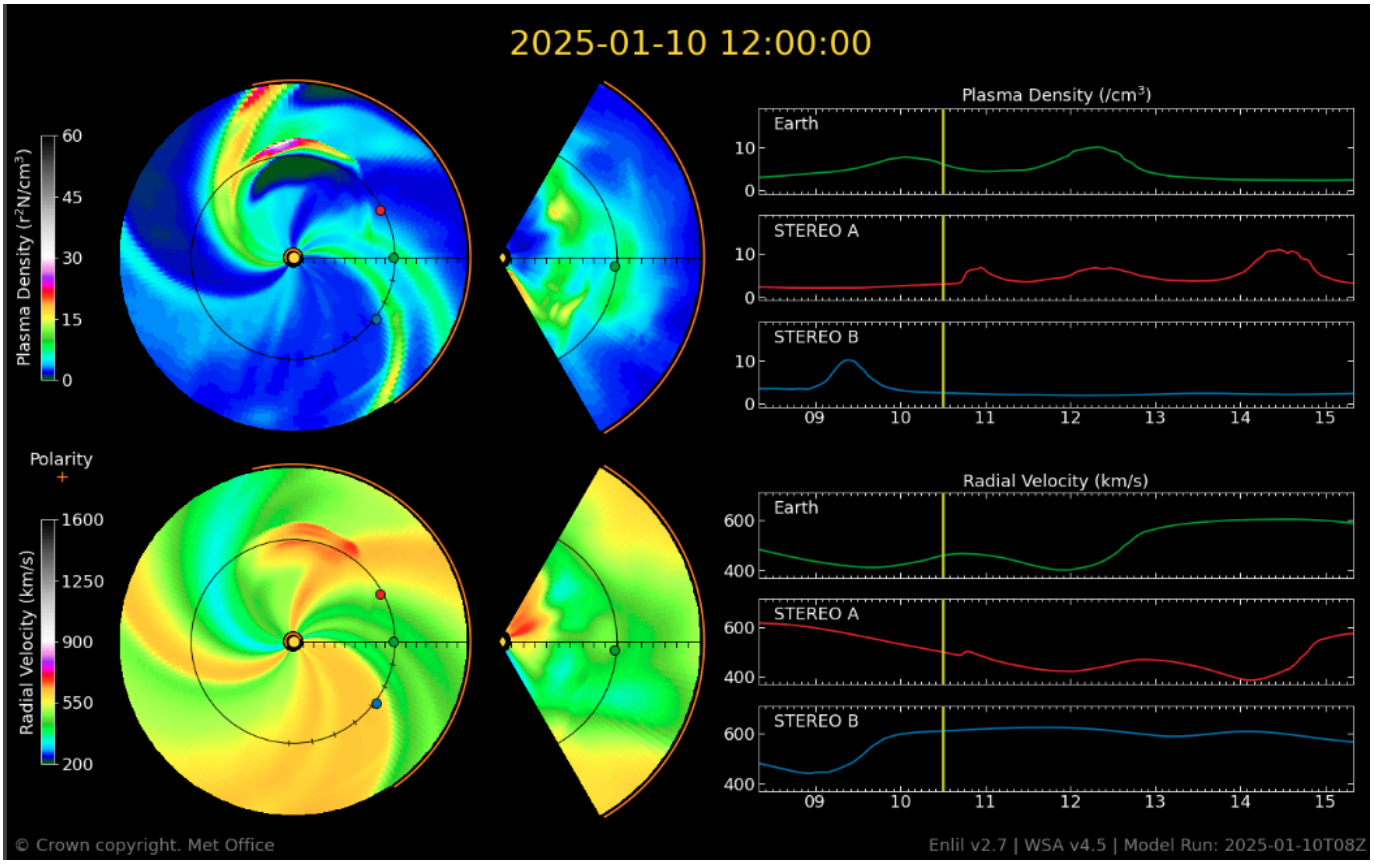
Figure 2: MOSWOC Enlil model. The enhancement in solar winds indicated in Enlil on 12 Jan and beyond looks too early, with the source, CH08/-, currently expected to be geoeffective from late 13 Jan onwards.



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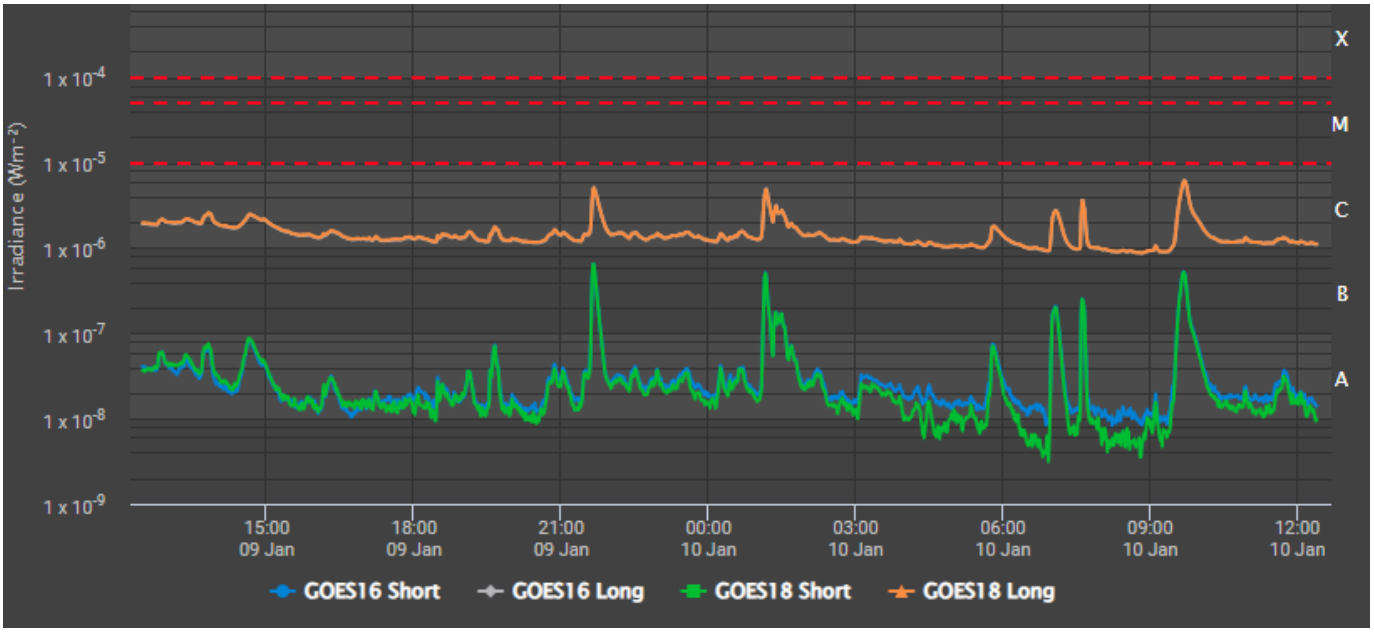
Radio Blackouts - X-Ray Flares

Low solar activity during the last 24 hours with only C-class flares, the largest a C6.1 at 10/0942 UTC appearing to originate from close to AR3945. There remains a chance of isolated M-class flares, primarily from AR3947.

There are eleven sunspot regions on the visible disc with AR3947 remaining the largest and most magnetically complex. This region has been responsible for the majority of flare activity over the past few days, although has shown a drop in significant flares this past 24 hours. Following a filament eruption close to this region at 09/1100 UTC a weak delta spot has redeveloped in its intermediate spots. AR3953 in the northwest has continued to show some growth. Several new unnumbered regions have developed over the past day, mostly small and simple, however the region in the northeast, recently numbered AR3956, has shown some rapid growth with penumbra forming on its leading and trailing portions. The other regions on the disc remain small and simple at present.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	50	50	50	50
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 3: GOES16 & 18 X-ray flux.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has remained at background over the last 24 hours. There is a slight chance of an enhancement as AR3947, the most complex spot, transits through the western hemisphere during the forecast period. This region has been the source of many M-class flares and isolated X-class flares, albeit with less in the way of significant flares recently. Furthermore, there are a number of filaments currently on the disc, and it is not impossible that a large eruption from any of these could result in Earth-directed high energy protons.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been varying between Moderate and diurnally High values over the last few days. This is as a result of the recent fast wind enhancement from CH05. Solar winds eased following this enhancement, but have since risen to slightly elevated levels again, possibly as an early connection to CH07. This has helped to compress the electron belts with measured electron flux dropping to background levels. Once any CH07 influence eases there is the possibility of a further increase in electron flux as the radiation belts expand back to incorporate GEO. However, there is some uncertainty as to the strength of any high speed stream from CH07, with the size of the coronal hole becoming obscured in imagery. Further complicating matters is the possibility of a CME from the 09 Jan filament eruption arriving over the UTC weekend, which could see the electron belts suppressed further. Overall, it is probable that electron flux values will be at Background to Moderate levels at first, perhaps diurnally High. Without any CME influence the electron flux is likely to increase later in the period, with diurnal High peaks becoming more possible.

Fluence approached the Active threshold but has since shown a declining trend as electron flux levels have dropped. It looks unlikely that the Active threshold will be reached early in the period, but a rising trend is possible later in the period if electron belts expand out once more and there is no CME influence observed. REFM seems a reasonable guide currently, perhaps not expressing the rising trend later in the period as suggested. Overall, this forecast is lower confidence than usual with the ongoing uncertainties in the Geomagnetic forecast.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	10	20	30	40
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

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Figure 4: GOES16 Electron flux

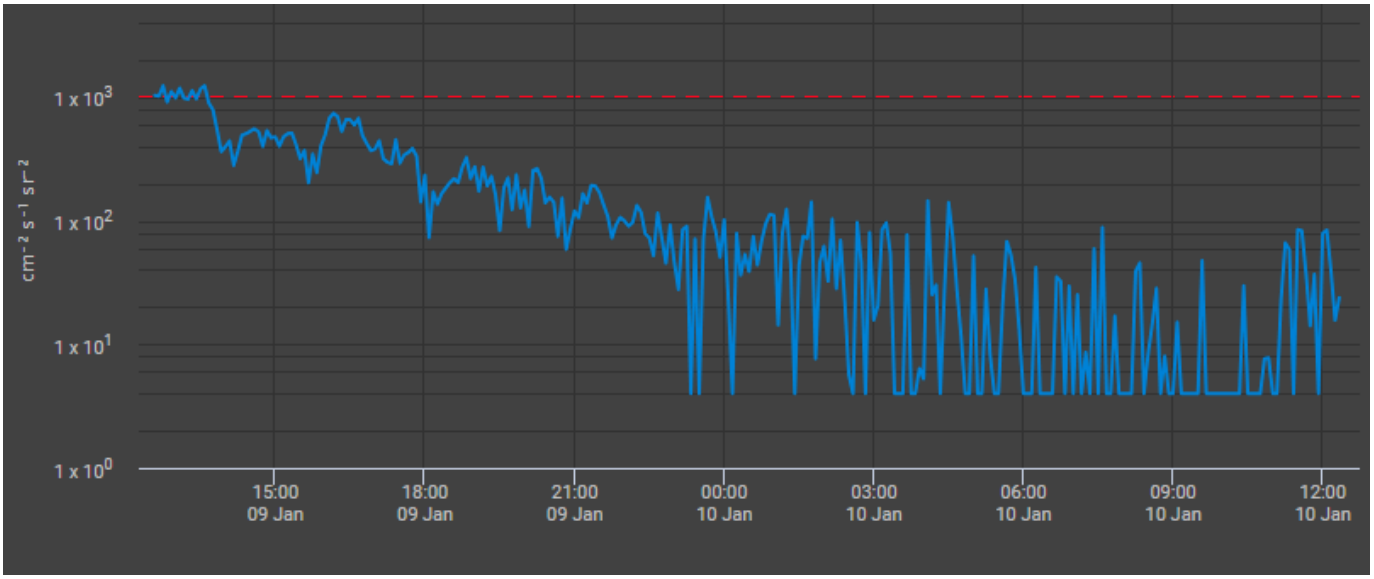
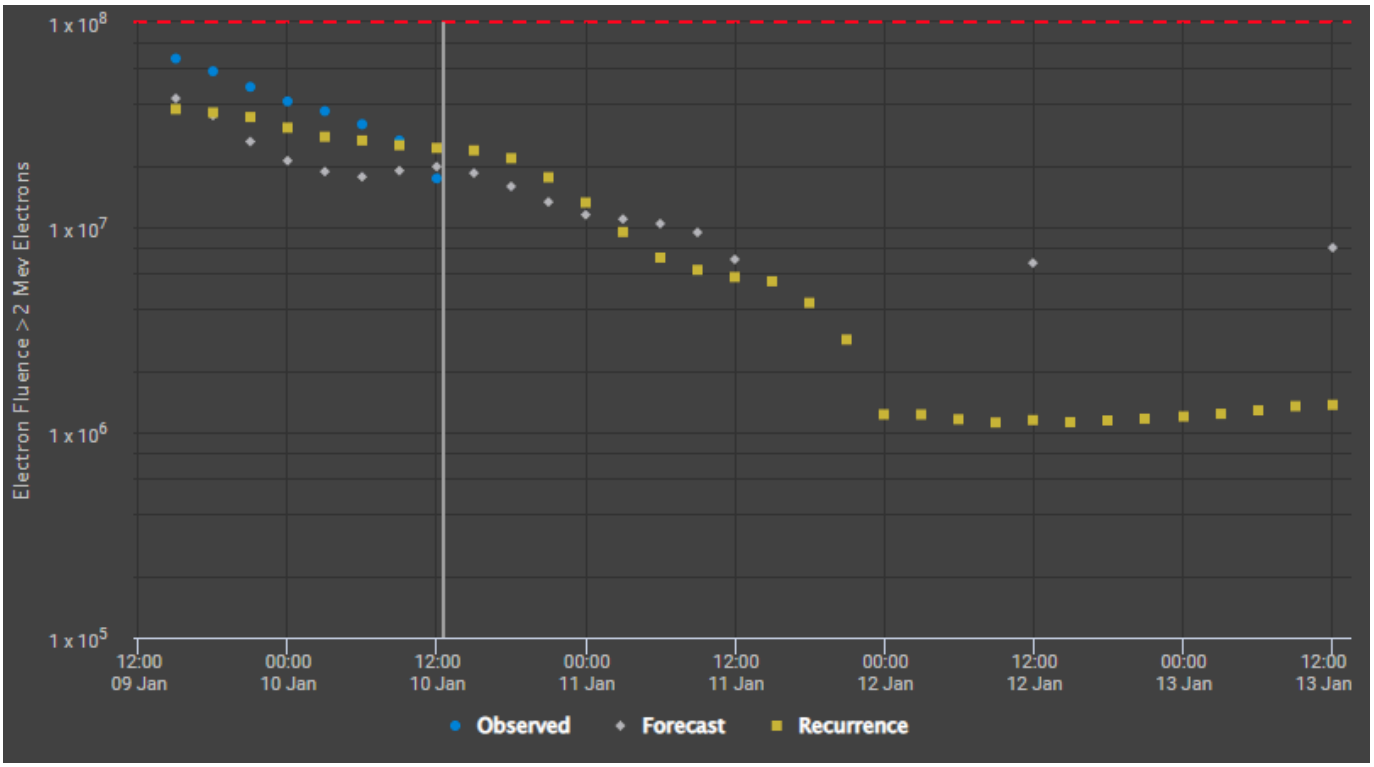


Figure 5: MOSWOC REFM



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